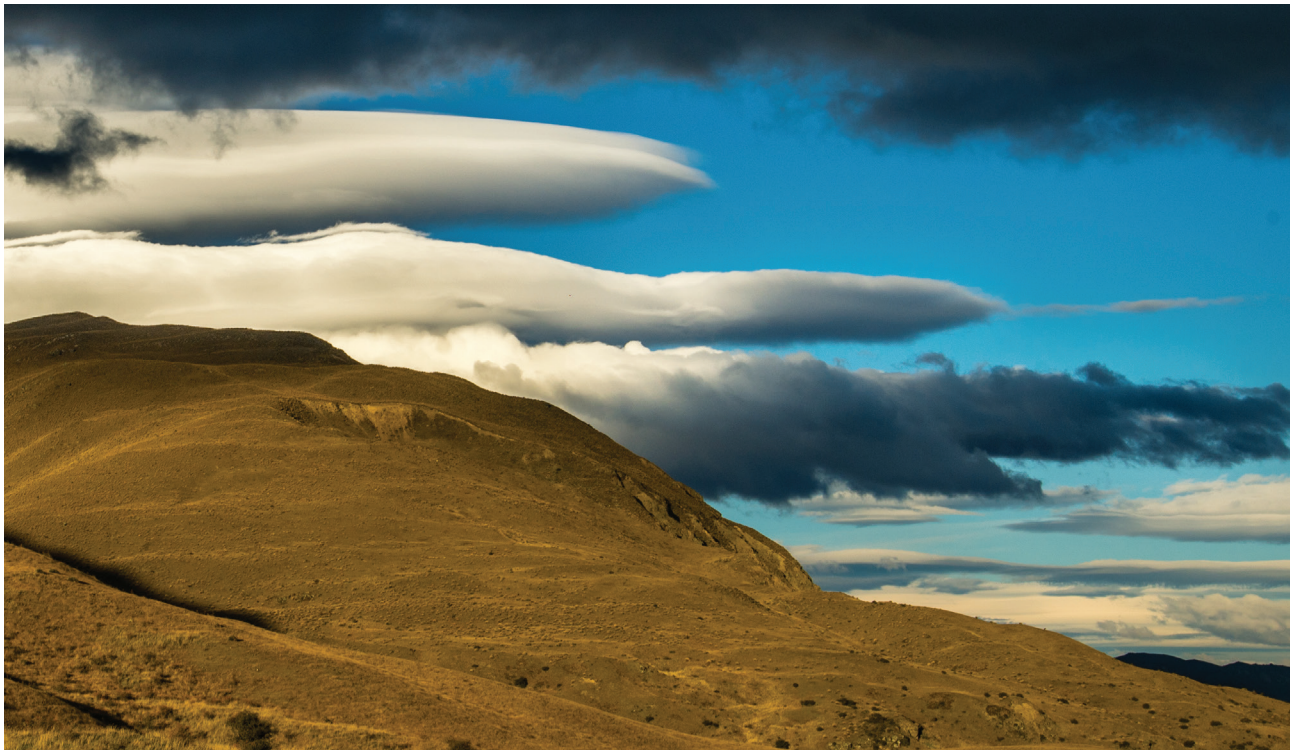
Reprint:
Kenntner, Perlwitz, Harris, Lee, Volkert
pp. 2-7

SPARC

Stratosphere-troposphere Processes And their Role in Climate

Newsletter n° 53
July 2019

www.sparc-climate.org



Lenticular clouds form over the Crown Range in New Zealand as strong winds are forced over the mountain range. A team meeting of the SPARC Gravity Wave Activity discussed parametrisation of drag created in such conditions in models, and how to improve observations and modelling of orographic wave drag (see report on page 31).

Photo credit: Katja Riedel Photography

Contents

WCRP World Climate Research Programme
WORLD METEOROLOGICAL ORGANIZATION
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission
International Science Council

JSC-40 meeting report

Mareike Kenntner[1], Judith Perlwitz[2], Neil R.P. Harris[3], Boram Lee[4], and Hans Volkert[1]

[1]SPARC Office, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany, **(office@sparc-climate.org)**, [2]Physical Sciences Division, NOAA Earth System Research Laboratory, Boulder, CO, USA., [3]Centre for Environmental and Agricultural Informatics, Cranfield University, UK, [4]WCRP Joint Planning Staff, WMO, Geneva, Switzerland.

The 40th Session of WCRP's Joint Scientific Committee (JSC) was held in Geneva from 6-10 May, 2019. Detlef Stammer (Univ. Hamburg) was elected as new chair, with Helen Cleugh (CSIRO) as new vice-chair of the JSC. The majority of the JSC members are new (**www.wcrp-climate.org/jsc-contacts**). Over the last year, the WCRP through its Joint Scientific Committee (JSC) and working with the broader climate science community, has produced a new Strategic Plan (SP) for the period 2019-2028 (**www.wcrp-climate.org/wcrp-sp**).

WCRP implementation plan

The next stage is for the JSC to work with the community to formulate an Implementation Plan (IP) and to ensure that the priorities outlined in the SP are implemented effectively. Along with the IP, a transition plan will be developed that ensures a smooth and uninterrupted transition from the current mode of working to the new WCRP structure.

During the weekend prior to the main meeting, a small group of core project co-chairs, working group leaders, JSC members and JPS staff met to develop a conceptual framework for the new implementation plan and the transition process. This draft was further developed during the first two days of the JSC-40 session. The plan focusses on connecting the expertise of the WCRP scientists with the necessary infrastructure (modelling resources, observation platforms, administrative support, *etc*) in order to develop the bedrock science to address societally relevant questions and help provide valuable information for decision makers. An important emphasis lies on being able to reach out to partners in all sectors and to use resources and partnerships in collaborations which facilitate WCRP's work. There is broad agreement of the need to better coordinate expertise within WCRP.

The discussions showed the large interest in constructive collaborations across the whole program, and led to a unified proposal from the co-chairs of the core projects and CORDEX. The proposal is to put certain regions of interest into the focus, where science from all core projects will provide input and be combined to understand the processes special to those regions. The co-chairs proposed to investigate the feasibility of projects on the Himalayas, the Arctic (and the Greenland ice sheet in particular), or the Andes, although other joint projects with more global focus were also discussed. The scope of the initially identified projects will be developed, with a progress report to be presented to the JSC in 2020. These project plans will take into account the gaps and priorities identified in the major scientific assessments such as IPCC AR6. The regional activities and projects therein will be coordinated and supported by the Coordination Office for Regional Activities (CORA; see below).

Visit **www.wcrp-climate.org/wcrp-ip-docs** for:

The Implementation and Transition Meeting Report. Please note that the report reflects discussions during the 2-day meeting, but also lists the key outcomes following the JSC-40, in particular, the timeline and conceptual framework, to avoid confusion.

A presentation containing information on the WCRP Strategic and Implementation Plans for dissemination their the key details the implementation process.

Planned schedule: **www.wcrp-climate.org/wcrp-ip-schedule**

Responses from Sponsors and Partners

A number of WCRP sponsors and partners attended the meeting offering their perspective on the strategic plan and the emerging implementation plan. **Elena Manaenkova** (WMO) noted the growing interest in more frequent assessments of the state of climate science (*e.g.* to complement the IPCC Assessment in a 5-7 year cycle) to inform climate policy, and that the WCRP community may play an important role therein. **Vladimir Ryabinin** (Intergovernmental Oceanographic Commission of UNESCO, IOC) stressed IOC's continued interest in sponsoring WCRP, noting especially the need for ocean science input to the upcoming UN Decade of Ocean Science for Sustainable Development (2021-2030). The IOC called for an active role of WCRP in developing a decadal science plan within this framework.

Concerning the WCRP implementation plan, **Salvatore Arico** later noted that the IP should present the relevance of science to society more clearly and specifically; meanwhile, consider potential risk that more scientific assessments might raise the tiredness in the policy arena.

Mathieu Denis (International Science Council, ISC) emphasised that it is important to work across the board. ISC's goal is that fundamental science is carried out in all disciplines, but it also strongly encourages engagement with stakeholders, and offers help connecting with communities. The ISC, too, appreciates that basic research is WCRP's core mandate and advises that it remains WCRP's focus.

On behalf of the WMO World Weather Research Program (WWRP), **Sarah Jones** reported that for the 20-year anniversary of the program an online museum on the history of weather research was developed (**www.tiki-toki.com/timeline/entry/1096683/Online-Museum-on-the-History-of-Weather-Research/**).

The strongest connection of the Global Atmospheric Watch (GAW) to WCRP is through the SPARC community. **Greg Carmichael** (Chair of the Scientific Steering Committee for Environmental Pollution and Atmospheric Chemistry) expressed his strong desire to maintain this good collaboration, and possibly to extend the collaborative arrangements to higher levels. The Global Climate Observing System (GCOS, **Stephen Briggs**) also strongly values WCRP as source of scientific requirements and feedback. The Global Framework for Climate Services (GFCS, **Filipe Lucio)**, is currently in a restructuring process, aiming at simplifying its governance structure. It is anticipated that WMO would maintain its priority for climate services in its strategic planning for 2020-2023.

Future Earth (**Amy Luers**) introduced the launch of the Earth Commission that aims to underpin the setting of science-based targets for a resilient planet, and an emerging effort to identify and facilitate the research on Global Systemic Challenges. She proposed that WCRP and Future Earth deepen collaborations through joint efforts particularly in the areas of sustainability research, as well as through science responses to policy requests. **Erica Key** (Belmont Forum) reported that Belmont Forum calls for proposals on climate topics are open and coming up, and expressed Belmont Forum's interest in developing closer ties with the WCRP research community in the future. She noted that the wording of the WCRP Strategy is well-chosen to resonate with possible future sponsors and partners, and reaffirmed the support of Belmont Forum for the open data concept. The Belmont Forum encouraged the WCRP community to consider reaching out to the private sector, which is already engaged in sustainability development and building resilience, and proposed to share Belmont Forum's 'lessons learned' in interacting with the private sector.

Updates from projects and panels

Pavel Kabat reported on the ongoing deliberation on the WMO governance reform that includes the changes in research coordination – a new Research Board (RB) and Scientific Advisory Panel (SAP) will be established. The continuous and increasing emphases for the organization are on the seamless and Earth system approach. WMO calls for closer collaborations of WCRP with WWRP, GAW and other external partners. Pavel Kabat noted that the emphasis of WMO in the implementation of a global agenda has grown, and subsequently, new alliances with the Green Climate Fund (GCF) and the World Bank have been cultivated; in this context, he noted on potential funding opportunities in the future through a more integrated coordination with the WMO programmes.

The Coordination Office for Regional Activities (CORA; **Beatriz Balino**, **Paul Bowyer**, **Daniela Jacob**, **Tore Furevik**) was launched in 2018 in order to identify opportunities, resources and partners to promote regional climate science throughout WCRP and the international research community. CORA is jointly hosted by the Climate Service Center Germany (GERICS) and the Bjerknes Centre for Climate Research (BCCR) of Norway. Specifically, CORA plans to support developing joint/integrative activities of Core Projects and CORDEX (**William Gutowski**) (and with other Working Groups) in regions, capacity building efforts and related outreach. In the starting phase, CORA will conduct a survey among the WCRP bodies to investigate what else they can do to support WCRP efforts. The JSC further suggested that The Working Group on Regional Climate Science and Information (WGRC, **Clare Goddess**), which has been stalled since 2016, works with CORA, GC-Extremes and other Core Projects and groups to develop regional aspects or projects within the new Implementation Plan (see also the core projects' proposal, above).

World**C**limate**R**esearch**P**rogramme

Majority of

Geneva

Joint**S**cientific**C**ommittee – **S**ession **40**

of Participants

7 / 10 May 2019

01 Huijun WANG, *JSC, CN*
02 Bo SUN, *support for **01**, CN*
03 Wenju CAI, *CLIVAR, AU*
04 Thomas PETER, *JSC, CH*
05 Xuebin ZHANG, *ETCCDI, CA*
06 Keith WILLIAMS, *WGNE, UK*
07 Neil HARRIS, *SPARC, UK*
08 Ken TAKAHASHI, *JSC, PE*

09 Iréne LAKE, *CORDEX, SE*
10 Jan POLCHER, *GEWEX, FR*
11 Masahide KIMOTO, *JSC, JP*
12 Paul BOWYER, *CORA (GERICS) , DE*
13 Silvina SOLMAN, *CORDEX, AR*
14 Peter VAN OEVELEN, *GEWEX, US*
15 Timothy NAISH, *GC Melting Ice, NZ*
16 Susanna CORTI, *JSC, IT*

17 Tore FUREVIK, *CORA, NO*
18 Daniela JACOB, *CORA , DE*
19 Pascale BRACONNOT, *JSC, FR*
20 Mareike KENNTNER, *SPARC, DE*
21 Jose SANTOS, *CLIVAR, CN*
22 Pedro MONTEIRO, *JSC, ZA*
23 Pavel KABAT, *chief scientist, WMO*
24 Helen CLEUGH, *JSC (vice-chair), AU*

25 Susann TEGTMEIER, *WDAC, DE*
26 Michael SPARROW, *JPS, WMO*
27 Michel RIXEN, *JPS, WMO*
28 William GUTOWSKI, *CORDEX, US*
29 Jean-Noël THÉPAUT, *WDAC/WMAC, ECMWF*
30 Igor SHKOLNIK, *JSC, RU*
31 Tercio AMBRIZZI, *JSC, BR*
32 Francisco DOBLAS REYES, *WMAC, ES*

33 Andrew ROBERTSON, *S2S, US*
34 Narelle VAN DER WEL, *JPS (consul.), WMO*
35 Graeme STEPHENS, *GEWEX, US*
36 Gwen HAMON, *CliC (consul.), NO*
37 Beatriz BALINO, *CORA, NO*
38 Lisa ALEXANDER, *JSC, AU*
39 James RENWICK, *CliC, NZ*
40 Hans VOLKERT, *SPARC, DE*

41 Judith PERLWITZ, *SPARC, US*
42 Krishnan RAGHAVAN, *JSC, IN*
43 Martin VISBECK, *JSC, DE (10 May)*
44 Boram LEE, *JPS, WMO*
45 Josefa POTTER, *JPS, WMO*
46 Matthias TUMA, *JPS, WMO*
47 James HURRELL, *JSC, US (10 May)*
48 Detlef STAMMER, *JSC (chair), DE*

Legend: **#**, given & SUR-name, *unit / role*, *country code*

Photos, fusion: Josefa Potter, Oliver Lux; Annotation: Hans Volkert

The Joint Scientific Committee (JSC) – the guiding body of the World Climate Research Programme (WCRP) – held its 40th annual session since 1980 at WMO headquarters in Geneva from 6 to 10 May 2019. After lunch on 7 May, 46 persons assembled for their photo opportunity on the staircase in the lobby of the WMO building. Two further JSC members were photographed at not yet taken positions on 10 May in order to construct the enhanced group depicted above. The addition of metadata in two columns (number, given and sur-names, unit within WCRP [cf. **www.wcrp-climate.org***], country code of workplace) helps demonstrate the geographical distribution across all continents and the diversity of the personalities involved in WCRP. The annotated groupphoto prolongs the tradition of similar undertakings of voluntary cooperation as described in a recent article (cf.* **https://doi.org/10.1007/s00376-017-6329-6).**

The CliC project (**James Renwick**) reported a very busy schedule in the current year. Its implementation has been closely linked with that of the Melting Ice and Global Consequences grand Challenge and with various MIPs.CliC has strong links to the CLIVAR and the CORDEX projects, and emphasised the need for fundamental understanding of glacier and ice sheet mass balances for near- and long-term predictions. A new CliC project office will be established this year.

The CLIVAR project (**Annalisa Bracco** & **Wenju Cai**) highlighted several short-term priorities in its future plans. These include (1) the ocean's role in transient climate sensitivity including changes in sea level under anthropogenically induced radiative changes and the ocean's contributions to energy, heat, water and carbon budgets, their perturbations and changes; (2) regional climate variability and change; (3) physical and biogeochemical interactions in the coastal ocean and changes to this vital and vulnerable region of the planet; and (4) variations in the climate mean state and their interaction with teleconnections and climate modes of variability. CLIVAR currently has an open call for a new Research Focus activity.

Jan Polcher and **Graeme Stephens** reported on behalf of the GEWEX project, emphasizing its integrative and multi-disciplinary nature with focus on processes, feedbacks and land-atmosphere coupling. GEWEX fundamentally underpins and strengthens the Earth system process studies, and displays strong regional foci involving many different regional and local communities. The GEWEX activity is well connected with the Water for Food baskets Grand Challenge (**Jan Polcher**), which is built upon the ongoing and planned Regional Hydroclimate Projects (RHPs) around dense agricultural areas. The aim is to better understand the water cycle and its implication to/interaction with the agricultural activities, and to improve understanding on the interactions of human activities (e.g. irrigation) and lower atmospheric system through field campaigns and model development / inter-comparisons. This Grand Challenge has reached out to other core projects for expertise on the Earth system.

The SPARC presentation (**Neil Harris**) emphasised the strength of the SPARC community, that was in part demonstrated at the successful SPARC General Assembly in Kyoto in 2018, and moreover, continuous bottom-up generation of ideas for new initiatives. It further highlighted recent progress of various SPARC activities, and collaborations between SPARC activities and with external partners. Neil Harris also pointed out the need for clarity on WCRP's way forward, as the current discussions on the internal structure of WCRP have put discussions on possible cooperation with other projects on hold. Finally, Neil Harris reminded everyone, that a Research Program focussed on climate change research should define a clear strategy for reducing its own carbon footprint, *e.g.* in the planning of activity meetings.

Catherine Senior described the huge achievement of the CMIP project and the work of the Working Group on Climate Modelling (WGCM). National institutions and centres contribute to CMIP in the order of 3 billion dollars. Most of the work providing input and coordinating the project is carried out on voluntary basis (a special, thankful mention of Veronika Eyring, the CMIP panel chair, was made). The distributed CMIP organisation has proven successful, and there are enough experiments and research questions in CMIP6 to fuel research over the next CMIP phase. Acknowledging that a large pressure has been placed on those volunteers' shoulders, WCRP should urgently seek ways to recognize all the contributors to the CMIP, as well as to secure firmer financial and coordinating support. All agreed that a serious review of the aims and structure of CMIP is needed to ensure that it meets WCRP's and IPCC's broader objectives. The current phase is moving towards its end, in terms of the model output relevant for the IPCC AR6 report. Modelling centres will continue to run CMIP6 experiments into 2020 and MIP analyses will continue over many years.

The Working Group on Numerical Experimentation (WGNE, **Keith Williams**) reports to WCRP and to the Commission for Atmospheric Sciences (CAS). WGNE has developed the AMIP and Transpose-AMIP methodologies, which contribute to the work on seamless prediction. Future science foci include convection, MJO task force work, surface fluxes, surface temperature, microphysics, and uncertainty representation. Other projects will continue their work on drag, aerosols and other topics. Over the last 30 years, many traditional differences between climate- and weather models have disappeared and the purpose of the working group has evolved into "fostering the development of earth system models for use in weather prediction and climate studies on all time scales, and diagnosing and resolving shortcomings". Several of these overlap with SPARC interests, and SPARC scientists should identify opportunities for productive collaboration.

61 articles using data from the Subseasonal-to-Seasonal Project (S2S, **Andrew Robertson**), a joint project of WCRP and WWRP, have been published and are reporting improvements in prediction skills, *e.g.* for MJO, or the Northern Annular Mode (in cooperation with SPARC). S2S, which is now entering its second phase, cooperates with most WCRP groups, as well as many external ones. A request for funding for an NCAR summer school (with SPARC support) in 2020 has been submitted. S2S was praised for its approach to involve scientists and centres from the beginning. It was also proposed that S2S could take a role in risk assessment studies.

The Working Group on Subseasonal to Interdecadal Prediction (WGSIP, **Doug Smith**) reported involvement in conference organisations, contributions to preparing guidance on seasonal forecasting for WMO regions, and basic scientific progress, *e.g.* ENSO influence on global circulation. WGSIP is closely linked with the S2S project. It will initialise new projects to focus on extremes, as well as Asian monsoon and ocean climate forecasting. Furthermore, the group considers becoming involved with CMIP and leading operational prediction assessments. Doug Smith also reported on the Decadal Climate Prediction Project (DCPP), which has been assessing the influence of initialisation in model runs and the prediction of extremes. This project will stay involved with CMIP6 analysis, and contribute to CMIP7. They are prepared to run forecasts to capture volcano impacts, if an eruption happens. He also mentioned the work of the Grand Challenge on Near Term Climate Prediction (GCNTCP), which has prepared its first issue of the Annual-to-Decadal Climate Update.

In 2018 the WCRP Modelling Advisory Council (WMAC, **Francisco Doblas-Reyes**) organised a summer school and awarded its 2018 International Prize for Model Development to Dr. Thomas Melvin (UK Met Office). This year's call for nominations opens in July with a deadline on 1 October. Nominations and applications by Early Career Scientists are strongly encouraged. The council reminds the JSC that managing modelling efforts need to be well coordinated, especially with the new focus in the Strategic Plan on seamlessness and Earth System models.

Francisco Doblas-Reyes suggested the formation of an Earth System model development working group. He also pointed out that "initialized simulations" represent opportunities to consolidate S2S-WGSIP-DCPP and connect more closely to NWP/WWRP towards seamless predictions.

The WCRP Data Advisory Council (WDAC, **Susann Tegtmeier**) has been active over the past years in working as a focal point for all observational and data matters across the program. WDAC has contributed to the CMIP project, and has created a new Surface Flux Task Team, with a white paper just finished. Among other tasks, this team will be a focal point for surface flux observations and analysis, and will establish publication and documentation standards for data and metadata. Furthermore, a proposal is being made to establish a WCRP Earth System Reanalysis Intercomparison and Evaluation group for the coordination of Reanalysis Intercomparison Projects (RIPs). SPARC's S-RIP project was mentioned as exemplary in involving the forecast centres in the work. WDAC calls for explicit inclusion of reanalyses in the WCRP infrastructure discussion. They also propose to write an official WCRP document on observations required for key research and the coordination of targeted field experiments. Finally, concerning data science and data management, WDAC envisions the promotion of transfer of knowledge from other disciplines and the identification of areas for international collaboration on big data and artificial intelligence. During the panel discussion, it became clear that it is important to not only collaborate with GCOS, but also use the Research Data Alliance of the ISC to consult on other possible partnerships.

The Grand Challenge on Extremes (**Jan Polcher**) presented continuous success in advancing scientific understanding, for example, by leading the IPCC AR6 chapter on weather and climate extremes. The presentation pointed out the many remaining questions to pursue, and the need to provide guidance for applications and services (*e.g.* guidance documents on the use of extreme dataset, on future projection of extremes). It was further stressed that interactions with other WCRP groups need to be well-organised to ensure cross-fertilisation and coordinated approaches. At the JSC session in 2018 (Nanjing), the Grand Challenge on Weather and Climate Extremes (GC Extremes) noted the discontinuation of the joint WMO/CCI-WCRP-JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI), which had underpinned many successful research activities on extreme data, analyses, development of indices and relevant attribution studies. At this year's JSC session **Lisa Alexander** and GC-Extremes leaders proposed a light-weight core-project-type activity on extremes (tentatively called Global weather and climate Extremes Project: GEP) to be a central hub to coordinate extreme-related activities toward and within the new WCRP. It could also provide internal science capability in formulating the WCRP position on extreme-relevant and policy-relevant issues such as attribution and prediction/projection of weather and climate extremes.

Following the WCRP workshop "The Earth's energy imbalance and its implications", November 2018 in Toulouse, France, a proposal was made to develop a WCRP-wide project/theme on this subject within a new implementation phase of WCRP. The proposal was based on the work of the CLIVAR research focus CONCEPT-HEAT (Consistency between planetary energy balance and ocean heat storage), Earth energy imbalance uncertainty assessment of GEWEX, and the collective discussions across all core projects and working groups to address the question on "Where does the Energy go?"

Outlook

The conceptual framework of the WCRP implementation plan was agreed at the JSC, and will be further discussed within the JSC and WCRP bodies. A draft structure and outline will be proposed to the WCRP community by April 2020 (at the JSC-41), during which period the focus will be to refine science questions, key elements for delivery and engagement, and the needs for funding and infrastructure. The full Implementation Planning will be an evolving process for 3 years until April 2022 (at the JSC-43). A structure and governance for the new WCRP will be developed and presented through thorough consultation with the full WCRP community, sponsors and partners, academics, and the climate service community. It was reaffirmed that the commitment of WCRP (and its co-sponsors) to Core Projects and their community involvement (*e.g.* Project Offices) will be maintained and further solidified as much as possible. All WCRP the groups (including all Core Projects) may be asked to provide a synthesis of their achievements, for consideration in the "landscape" of the new WCRP.

The initial set of key science questions within the new Implementation Plan will be refined via consultation

with Core Projects (referring to their respective Science Plans), and considering various horizon-scanning done by partners and aligned groups (*e.g.* IPCC); for example, with respect to the needs of mitigation and adaptation strategies relevant for the communities in the post-Paris era.

The JSC discussed the need and possible extent of informing climate policy process of the state and gaps in science/research. As a recognized partner of UNFCCC for science and research, WCRP has been providing science input to the Subsidiary Body for Scientific and Technological Advice (SBSTA) through the Research Dialogue (RD). An EarthInfoDay during the COP-22 (2016) was another good example addressing the Parties of the status of our understanding, knowledge gaps and opportunities in earth observation and global climate (change) science that elevated the Parties' attention to the need for systematic and synthesized reporting on the status of science. And there has been growing expectation on whether WCRP could coordinate a synthesized report on the state of climate research on a regular basis, to complement the peer-reviewed but less-frequent reference of IPCC assessments.

As part of the celebration for WCRP's 40-year anniversary, a climate science week is being organized during the AGU fall meeting in December 2019. It will start with a Symposium on Sunday, 8 December, and will continue throughout the whole week with WCRP science sessions, workshops, and town hall meetings, and ending with a WCRP union session on the Friday. In parallel, an Early Career Scientists (ECS) conference on climate science will be organized together with its community partners and ECS networks. Details of the program can be found at: **www.wcrp-climate.org/wcrp-agu2019**.

SPARC SSG members in 2019:

Neil Harris, co-chair
Centre for Environment and Agricultural Informatics, Cranfield University,
Cranfield, UK

Judith Perlwitz, co-chair
ESRL, NOAA,
Boulder, CO, USA

Gufran Beig
Indian Institute of Tropical Meteorology,
Pune, India

Wen Chen
Center for Monsoon System Research at IAP, Chinese Academy of Sciences,
Beijing, China

Harry Hendon
Bureau of Meteorology,
Melbourne, Australia

Nathaniel Livesey
NASA-JPL,
Pasadena, CA, USA

Karen Rosenlof
NOAA/ESRL,
Boulder, CO, USA

Kauro Sato
Department of Earth and Planetary Science, University of Tokyo,
Tokyo, Japan

Hauke Schmidt
Max Planck Institute for Meteorology in Hamburg, Germany

Seok-Woo Son
Seoul National University,
Seoul, Republic of Korea

Donald J. Wuebbles
University of Illinois,
Urbana, IL, USA

Tianjun Zhou
LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences,
Beijing, China

Boram Lee
Senior Scientific Officer and SPARC liaison at the WCRP Joint Planning Staff, WMO,
Geneva, Switzerland

The JSC has approved the appointment of **Prof. Nili Harnik** (Tel Aviv University, Israel) and **Prof. Takeshi Horinouchi** (Hokkaido University, Japan), who will join the SPARC SSG in January 2020.

Personal reflections on the outlook for SPARC

The future development of WCRP is beginning to become clearer in practical terms. The constructive discussions at the Joint Steering Committee meeting (above) confirmed the rationale laid out in the new Strategic Plan and, importantly, developed a framework to bring the strategy to life. Our major concern in the past has been the apparent uncertainty on the level of support for communities within WCRP. Their value in both developing new ideas and in training early career scientists is now widely acknowledged: communities will play a major role in the future WCRP. Having said that, WCRP must stimulate the evolution of new communities to meet the new research needs outlined in its Strategic Plan.

The Implementation Plan is now being prepared. An important part of this is the WCRP Climate Science Week at AGU in December (**www.wcrp-climate.org/wcrp-agu2019).** A special WCRP 40th Anniversary Symposium will be held on Sunday 8th December which will celebrate the first 40 years of WCRP as well as launch the new phase of WCRP science. Other WCRP events will be held throughout the week. The aim is for this plan to be refined over the following two and a half years in an extensive consultation period. WCRP is a necessarily complicated structure – it supports the research underlying the ever more complicated climate models. It is critically important that the new Implementation Plan is properly thought through in detail.

From a SPARC perspective, the central role of the atmosphere and its interactions with other components of the climate system in WCRP science is becoming increasingly recognised. The lack of a central activity on tropospheric composition and radiative forcing – and especially the climate forcing agents – is a historical quirk. (SPARC successfully addresses the 'stratospheric' forcings.) Deep understanding of long- and short-lived climate forcing agents will underpin advice on how to minimise increases in radiative forcing in the critical next 40 years: WCRP has to help achieve this. This will require cooperation with many existing activities outside WCRP (WMO's GAW and Future Earth's IGAC, SOLAS, ILEAPS to name but four). A similar situation exists for the larger scale atmospheric dynamics in which SPARC plays the leading role. For example, addressing sub-seasonal to decadal prediction is requiring the input from many current disciplines and activities. S2S is an exemplar in bringing the expertise of many interests to address this issue.

Our view is that WCRP will need discipline-centred themes into the foreseeable future. Given the strength of existing infrastructure, it is hard to see what can successfully replace core projects in the medium term. Offices, newsletters, General Assemblies, focussed workshops and conferences all play a central role in coordinating global climate science. SPARC has a special role in view of its support for the Montreal Protocol as well as UNFCCC process. Issues such as the unreported CFC-11 emissions and the ozone trend in the lower stratosphere show that the area is still very much alive.

However, SPARC and the other core projects must continue to evolve in order to support WCRP's aims. The core project-led initiative at the JSC is a good example of collaborative generation of new, broad initiatives. Such cross-cutting science activities are likely to become the norm, not the exception, in future. Generating cutting edge ideas and clear plans for these is critical.

In the case of SPARC, we are starting to prepare the strategy for 2021-2025. It will be based around the continued existence of SPARC, but will have clearer emphasis than before on how the SPARC strategy supports the WCRP strategy and society's needs more generally. A large number of studies presented at the General Assembly directly address challenges faced by society. In addition to working with a wider a range of natural scientists, more work with economists, social scientists, private sector, *etc.* is likely with co-design of projects becoming a standard approach to proposal development - not the only one, but a widely used one. Having said that, it is critical that the type of high quality scientific research promoted by SPARC remains the bedrock of WCRP. Successfully achieving this balance between doing excellent research and addressing practical societal questions is an exciting challenge for SPARC scientists in the coming years.

Neil Harris and Judith Perlwitz (SPARC co-chairs)